LED Systems for Greenhouse Plant Lighting

Light on a plant canopy, irrespective of its source, can be analyzed in terms of spectrum, amount, spatial distribution, duration and timing; and a plant's response to light can be functionally related to these dimensions. It is possible to examine how each dimension affects plants so that light technologies and control strategies, both optical and temporal, can be prescribed for improving yield. As further research is conducted, greater precision in predicting plant responses can be achieved.

Plants grown in greenhouses receive light from daylight and from electric light sources such as high-intensity discharge, usually high-pressure sodium (HPS), and light-emitting diodes (LEDs). HPS generates a great deal of photosynthetic energy for relatively little electric power. However, HPS does not easily provide the opportunity to change the amount or spectrum for optimal plant growth.

Notwithstanding their relatively high cost at this time, LEDs are inherently ideal sources for plant growth because they can be so well controlled in terms of amount, spectrum, duration and timing. With secondary optics, their spatial distribution can also be tightly controlled. An often overlooked advantage of LEDs is that they come in discrete packages such that single elements in a luminaire can be controlled in every dimension. Given this unprecedented control, LEDs are ideal research tools for better understanding how plants respond to optical radiation.

Lighting control systems could potentially be developed to optimize photosynthetic radiation specific for the plant species, and to shape their morphology and chemistry. Opportunities for cost-effective control systems appear to be great where the amount, spectrum, duration, distribution and timing of light exposure can be precisely controlled daily, seasonally and during plant growth for maximum yield.

Future steps include development of control system software and research on the spectral, temporal and spatial effects of light on plant growth, morphology, and chemistry.

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